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TRANSMITTAL OF APPEAL BRIEF (Large Entity)

Docket No.
01-SM5-423

In Re Application Of: Alan C. Janos et al.

17#

Serial No.	Filing Date	Examiner	Group Art Unit
10/004,523	11/01/2001	A, Minh D.	2821

Invention: PLASMA PROCESS AND APPARATUS

TO THE COMMISSIONER FOR PATENTS:

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed on

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Peter R. Hagerty
Registration No. 42,618
Customer No. 23413
Telephone No. 860-286-2929

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Rebecca L. Blake

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01-SM5-423
(ATI-0008-P)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Alan C. Janos et al.	Before the Board of Appeals
Serial No.:	10/004,523	
Filed:	November 01, 2001	Appeal No.: Not yet assigned
For:	PLASMA PROCESS AND APPARATUS	Group Art Unit: 2821

APPEAL BRIEF

I. REAL PARTY IN INTEREST

The real party in interest in this appeal is Axcelis Technologies, Incorporated, Beverly, Massachusetts.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to appellants, appellants' legal representatives, or assignee, which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF THE CLAIMS

Claims 1-36 are pending in the application. Claims 1-36 stand finally rejected. The final rejection of Claims 1-36 is appealed.

IV. STATUS OF AMENDMENTS

An Amendment was filed on October 14, 2003 in response to a Final Office Action. Per the Advisory Action dated October 29, 2003, the amendment was not entered for purportedly adding new matter. The newly added claim (Claim 37), directed to a plasma tube, combined all of the features found in pending Claim 1and Claim 6, dependent thereon. Applicants are at a loss as to how this constitutes new matter since the features were merely a combination of Claims 1 and 6, which presumably would have been searched during the

normal course of prosecution. Regardless, Claims 1-36 were pending in a previous amendment filed on May 30, 2003. A copy of the pending Claims 1-36 as presented in the previous amendment filed on May 30, 2003 is shown in Appendix A, attached hereto.

V. SUMMARY OF THE INVENTION

The present invention relates generally to fabrication of integrated circuits, and more particularly, to plasma mediated processing and apparatuses employed for fabricating the integrated circuit.

As noted in Applicant's background section, specialized tools utilized in the integrated circuit fabrication processes include, but are not limited to, photolithography tools, etchers, ashers, photostabilizers, ion implantation equipment, and the like. A significant number of these tools expose the wafer or selected portions of the wafer to a plasma. Some plasma-mediated processes employ plasma discharges that are either difficult to ignite, or ignite, but do so irreproducibly with variable delays before ignition is achieved. Once ignited, these discharges are typically sustained with lower required voltages or reduced electric fields. Unfortunately, variability in ignition can lead to variability in processing, inefficiencies, and reduced throughput.

Applicants have addressed the need for decreasing variability in plasma ignition by enhancing the ignition of a gas to form the plasma. Applicants have discovered that placing conductive fibers in or near a plasma discharge volume locally enhances the applied electric

field so that plasma can be initiated at higher pressures, at lower electric fields, and/or in otherwise difficult gases to ignite. Advantageously, the process and apparatus reduces the overall process times for igniting the gas and forming a stable plasma discharge. As a result, wafer throughput for plasma-mediated processes is increased, thereby providing a significant commercial advantage.

In Applicants detailed disclosure, the conductive fiber is described as being disposed in close proximity to a wall of a plasma tube, wherein the plasma discharge volume is first generated. The conductive fiber is secured to an interior wall of the plasma tube or may be coated with a protective coating. The plasma tube is generally an open-ended elongated cylindrical body fabricated from quartz, sapphire, alumina-coated quartz or like material that is used for plasma-mediated processes. The plasma tube includes a gas feed inlet at one end and plasma exhaust at the other end. The plasma exhaust is generally discharged into a processing chamber. Gases flowing through the tube are excited with an external energy source to breakdown the gases and form the plasma discharge volume.

The presence of the conductive fibers of a conductive fiber within or in close proximity to the plasma discharge volume has been found to enhance the local electric field. The conductive fiber allows charges (i.e., electrons) to accumulate at each end, thus distorting and enhancing the local electric field within the plasma tube. The gas flowing through the plasma tube 18 is exposed to the enhanced local electric field, breaks down, and becomes conductive. It is believed that because the fiber resistance is high relative to the volume resistance of the

steady state plasma; the fiber does not couple significant energy during steady state operation. This reduces the field enhancement at the tips of the fiber during steady state operation, consequently reducing plasma disturbance and overheating of the fiber during operation.

The orientation, or angle, of the fiber with respect to the applied electric field is aligned to the applied electric field since charge separation and build-up can only occur along the length of the fiber. More preferably, the fiber is substantially parallel to the applied electric field. With a fiber of fixed length oriented at an angle not substantially parallel to the applied electric field, its effective length along the electric field is reduced by cos θ, where θ is the angle of the fiber with respect to the electric field. Thus, conductive fibers at angles perpendicular to the applied field would not enhance the electric field and break down of a plasma gas. However, at angles less than perpendicular to the applied field, there is enhancement of the electric field causing a reduction in the electric field breakdown point of a gas.

In summary, only those conductive fibers secured to the body of plasma tube and positioned to enhance an electric field in accordance with the teaching provided by the Applicants have resulted in decreased variability in plasma ignition. Moreover, it should be noted that the conductive fibers are not connected to a voltage power source but, rather, serve to enhance a local electric field and reduce an electric field breakdown point of a gas form the plasma.

VI. ISSUES

1. Whether Claims 1, 3-4, 9, 11, 14, 16-17, 19-20, 25-26, and 28 are unpatentable under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 4,922,099 to Masuda et al.

2. Whether Claims 2, 5-8, 10, 12-13, 15, 18, 20-24, 27, and 29-36 are unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 4,922,099 to Masuda et al.

VII. GROUPING OF CLAIMS

Claims 1-13 directed to a plasma tube stand together; Claims 14-24 directed to a plasma tool stand together; and Claims 25-36 directed to a process for reducing the electric field breakdown point of a gas stand together.

VIII. ARGUMENTS

1. Claims 1, 3-4, 9, 11, 14, 16-17, 19-20, 25-26, and 28 are not anticipated under 35 U.S.C. §102(b) by U.S. Patent No. 4,922,099 to Masuda et al. (hereinafter "Masuda").

The cited reference will first be briefly summarized. Masuda generally describes electric field devices. The electric field devices include planar and cylindrically shaped electric field devices having various electrode configurations. Masuda teaches applying a voltage power source to all of the electrodes to create an electric field, which can be used for a variety of applications. None of the electrodes disclosed in Masuda are free from connection to the voltage power source. In fact, Masuda is very creative in connecting its electrodes to the voltage power source detailing the use of tunnels and through-holes in a dielectric material to

provide connection of all electrodes to the voltage power source. The electrodes may be serially connected or connected in parallel. Because of its configuration, the electric field produced by the electric field devices is across a dielectric material.

In rejecting Claims 1, 3-4, 9, 11, 14, 16-17, 19-20, 25-26, and 28, the Examiner has cited the Masuda reference as relating that:

> Masuda discloses the electric field device comprises an open end cylindrical body (28) having a gas inlet (89) at one end, and an outlet (95) at an other end and at least conductive [fibers] (66 or 67 or 68 or 3-5) secured to the body (96) and positioned to enhance an electric field, wherein the at least one conductive fiber is free from connections to a voltage power source, (see figure 1F, the voltage power source (19) is only connected to electrode 5 and 9). See figures 19-22, col. 15, lines 4-68, col. 16, lines 1-53.

(Final Office Action dated August 12, 2003, page 2)

To anticipate a claim under 35 U.S.C. §102, a single source must contain all of the elements of the claim. *Lewmar Marine Inc. v. Barient, Inc.*, 827 F.2d 744, 747, 3 U.S.P.Q.2d 1766, 1768 (Fed. Cir. 1987), *cert. denied*, 484 U.S. 1007 (1988). Applicants' claims to the plasma tube (Claims 1-13), the plasma tool (Claims 14-24), and the process (Claim 25-36) have, in common, the feature that conductive fibers are secured to an open ended cylindrical body, which are free from connection to a voltage source. Masuda fails to disclose fibers that are secured to an open ended cylindrical body, which are free from connection to a voltage source.

To support the allegation that Masuda teaches at least one conductive fiber free from connection to a voltage power source, the Examiner first refers to Figure 1F as describing "the voltage source (19) is only connected to electrode 5 and 9. First it is noted that the structure referred to by the Examiner is a planar electric field device. Applicants' have claimed an open ended cylindrical body. Secondly, and more importantly, the Figure does not show a conductive fiber that is free from connection to a voltage source; each one of the electrodes shown in Masuda is connected to a voltage power source. Figure 1F is the last in a series of views (Figures 1A to 1F) illustrating the same planar electric field device. Figure 1F happens to be a cross sectional view. Upon reviewing the preceding figures, which illustrates a perspective view of the electric field device, it is clear that electrodes labeled as 3 and 4 are also connected to the voltage power source. Moreover, Masuda clearly states in its detailed description that the electrodes are connected to a common conductor so as to provide a corona discharge from the electrodes upon application of a voltage power source.

> . . . a plurality of electrodes 3, 4 and 5 directed in the lengthwise direction of about 1 mm in width and about 100 um in thickness at an interval of about 5 mm with ink having tungsten micron-fine powder dispersed therein though a screen printing technique, further these electrodes are connected to a common conductor 6 printed though a similar method, and then a terminal conductor 7 is further connected by printing.

(Masuda, Col. 7, line 65 to Col. 7, line 5)

> . . . the group of corona electrodes 3, 4, and 5 on the front surface of the dielectric plate 18 are connected through the common conductor 16 and the terminal conductors 7 and 7a to the disc shaped terminal conductor portion 16 on the rears of the dielectric plate.

(Masuda, Col. 7, ll. 53-59)

> If a high frequency A.C. high voltage is applied from a high frequency A.C. voltage source 19 via the terminal conductor portions 15 and 16 not shown between the corona electrode group 3, 4,and 5, an the planar induction electrode 9 by the intermediary of the fine ceramics dielectric layer 20 (the electrodes 3, 4 and 5 being grounded for the purpose of safety, then high frequency corona discharge is generated from the edges of the electrodes 3, 4 and 5 along the surface of the dielectric plate...

(Masuda, Col. 8, ll. 4-13)

By connecting one of the electrodes to a voltage power source as described and shown in Masuda, all of the electrodes, e.g., 3, 4, and 5, are in electrical communication with the voltage power source. <u>Thus, the Examiner is technically wrong in stating that Masuda teaches an electric field device that has at least one conductive fiber free from connection to a voltage power.</u> <u>All of Masuda's electrodes in its electric field devices are directly or indirectly connected to a voltage power source.</u> This makes sense since, in order for Masuda's electric field devices to function, there must be a voltage source in electrical communication with the electrodes disposed in the electric field devices. In contrast, Applicants claims include, *inter alia*, at least one conductive fiber free from connection to a voltage power source. Even

without direct connection to a voltage source, Applicants conductive fibers function by enhancing the electric field locally and have nothing to do with generation of an electric field as taught in Masuda.

The Examiner also refers to Figures 19-22 for providing support that all of Applicants' claim elements are disclosed, including the feature of at least one conductive fiber is free from connection to a voltage power source. However, similar to that shown in Figure 1F, all of the electrodes in the electric field device are connected to voltage power source. The only difference is that the electric field device has an open ended cylindrical shape as opposed to the planar electric field device of Figures 1A-1F. Having each electrode connected to a voltage power source makes sense since Masuda is directed to electric field devices and rely on energizing the electrodes to produce the electric field. As such, in order for the electric field device to function it must be connected to an external power source. In Figures 19-22, each one of the electrodes (66, 67, and 68 as referred to by the Examiner and shown in Figures 19-22) is illustrated as being connected to a voltage power source 70. Moreover, as described in Masuda's specification, "...a three phase A.C. voltage power source 70 are applied to said electrodes by way of terminal conductor parts 66, 67, and 68,..." (see Col. 15, ll. 18-25). Thus, Masuda's electric field device fail to teach at least one conductive fiber is free from connection to a voltage power.

In view of the foregoing, <u>the Examiner's technical assessment of what Masuda actually discloses is clearly and unequivocally wrong</u>. Because of this, Masuda fails to teach at least

one claim element, e.g., the feature of at least one conductive fiber that is free from connection to a voltage power source or a conductive fiber positioned to enhance an electric field, and thus, fails to anticipate any of the claims that include this feature. Since all claims include this feature, the claims are not anticipated. The cited reference is therefore deficient to support a section 102 rejection since not all claim elements are inherently or positively disclosed.

2. Claims 2, 5-8, 10, 12-13, 15, 18, 20-24, 27, and 29-36 are patentable under 35 U.S.C. § 103(a) over U.S. Patent No. 4,922,099 to Masuda et al.

To establish a prima facie case of obviousness, three basic criteria must be met. First, the prior art reference (or references when combined) must teach or suggest all of the claim limitations. Second, there must be a reasonable expectation of success. Finally, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck,* 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). The Examiner has failed to meet these criteria.

Applicants assert that a prima facie case of obviousness has not been made against Claims 2, 5-8, 10, 12-13, 15, 18, 20-24, 27, and 29-36. A prima facie case has not been established because Masuda fails to teach or suggest an open ended cylindrical body including the feature of at least one conductive fiber secured to the body and positioned to enhance an

applied electric field, wherein the at least one conductive fiber is free from a connection to a voltage power source. Nowhere in Masuda does it even suggest his invention could work without direct connection of its electrodes to a voltage source. Nor would one skilled in the art conclude that Masuda's invention could work without direct connection of its electrodes to a voltage source since Masuda is directed to electric field devices for generating an electric field. This is different from enhancing an electric field from an already existing electric field generated by an external power source, e.g., microwaves, RF frequencies, etc. Without connection to a voltage source, Masuda's electric field devices would not function as intended. Moreover, as discussed immediately above, Masuda fails to teach or suggest that its electrodes enhance the electric field as claimed by Applicants. Masuda teaches and suggests that every electrode in its electric field device is connected to a voltage power source. Thus, Masuda fails to teach or suggest all of the claim limitations.

It should also be pointed out that simply turning off Masuda's electric field devices does not remove its connection to the voltage power source as alluded to during discussions with the Primary Examiner. The reference must teach or suggest all of the claim limitations. Masuda fails to teach or suggest a conductive fiber free from connection to a voltage source as claimed by Applicants.

With reference to the Examiner's comments regarding Claims 20 and 26, Masuda does not disclose light being focused. Again, it appears that the Examiner does not understand the reference being cited or the subject matter of Applicants' claims. The Examiner is

requested to carefully read the reference prior to making erroneous statements regarding the technology that serves as the basis for his rejections.

The Examiner has also failed to show that Masuda contains some suggestion or motivation to modify its electric field device so that there is at least one conductive fiber in its electric field device that is free from a connection to a voltage power source. Applicants have carefully studied Masuda and can find no such suggestion or motivation. Masuda is generally directed to electric field devices that require a voltage source to be connected to each of its electrodes for its invention to function as intended i.e., function as an electric field device. Each of the electrodes in the electric field device produces an electric field through a dielectric upon being energized with the voltage power source. Masuda's patent devotes much time and goes through great pains to make these conductors connect through tunnels and holes, through dielectrics, in order to connect all conductors. Based on the intended use of the electrodes to produce the electric field, there is no motivation whatsoever to modify the reference to include at least one conductive fiber that is free from connection to a voltage power source as claimed by Applicants and/or positioned to enhance an electric field. A conductive fiber free from connection to a voltage power source in Masuda's electric field device would have no purpose, would not function as intended, and would not produce an electric field. One of ordinary skill in the art based on existing knowledge would not be motivated to free the connection of any of the electrodes described in Masuda's electric filed devices from a voltage source sicne it would no longer function as intended.

Moreover, in Masuda, electric field is strongest at the sides of the conductors, where most of the work is done and, in addition, it is noted that the electric field is across the dielectric. This is markedly different from Applicant conductive fibers, wherein the electric field occurs in a volume of gas and the discharge created by the fibers occurs at the ends.

Thus, independent Claims 1, 14, and 25 are patentably distinguished from Masuda since Masuda fails to teach or suggest at least one conductive fiber secured to the body and positioned to enhance an applied electric field, wherein the at least one conductive fiber is free from connection to a voltage power source. Likewise, dependent Claims 5-11, 13, 18-19, and 23-24 are patentably distinguished from Masuda since these claims also include the features recited in the base claim.

In addition, it is also pointed out that Independent Claim 25 is further distinguished because Masuda does not teach or suggest a process for reducing an electric field breakdown point of a gas. If anything, Masuda can be interpreted as teaching away from a process for reducing the breakdown reducing the electric field breakdown point of a gas since it is generally directed to generating an electric field by energizing electrodes with a voltage power source. All of the electrodes are energized by connection with a voltage source presumably to maximize the electric field generated. Since Masuda is concerned with generating an electric field, it seems counterintuitive to include conductive fibers in its electric field device since these clearly would not generate an electric field as intended by Masuda. As such, there is no disclosure or suggestion or reducing the electric field breakdown point of a gas.

Applicant respectfully asserts, second, that the Examiner has failed to establish a prima facie case for obviousness inasmuch as that case relies on any of the cited references, alone or in combination, to provide an expectation of success for Applicants' invention. "Both the suggestion <u>and the expectation of success</u> must be found in the prior art, not in applicant's disclosure." [emphasis added] *In re Dow Chem.*, 837 F.2d 469, 473, 5 U.S.P.Q.2d 1529, 1532 (Fed. Cir. 1988). As discussed in the Summary section above, Applicant's conductive fibers, free from connection to a voltage power source, are positioned to enhance the electric field of a gas. To do this, the fibers are oriented at an angle less than perpendicular to the applied field. This is not obvious since those skilled in the art were previously of the belief that orienting the fibers at angles less than perpendicular to the applied filed would cause shorts in the electric field and, if anything, make ignition more difficult as opposed to less difficult. By connecting all of its electrodes to the voltage power source, there is no expectation of success in Masuda of enhancing an electric filed. In Masuda, the electrodes produce the electric field, which is markedly different from enhancing an already existing electric field and reducing the electric field breakdown voltage of a gas.

The cited references are therefore deficient to support a prima facie case of obviousness against any of Applicants' Claims 2, 5-8, 10, 12-13, 15, 18, 20-24, 27, and 29-36.

IX. CONCLUSION:

In view of the foregoing, it is urged that the final rejection of Claims 1-36 be overturned and Claims 1-36 be allowed. The final rejection is in error and should be reversed.

If there are any additional charges with respect to this Brief, please charge them to Deposit Account No. 06-1130 maintained by Applicant's attorneys.

Respectfully submitted,

CANTOR COLBURN, LLP

By: ______________________

Peter R. Hagerty
Registration No. 42,618

Date: November 10, 2003
Telephone (860) 286-2929
Facsimile (860) 286-0115
Customer No. 23413

X. APPENDIX A: PENDING CLAIM STATUS

1. A plasma tube comprising:

an open ended cylindrical body, wherein the body includes a gas inlet at one end, and an outlet at an other end; and

at least one conductive fiber secured to the body and positioned to enhance an electric field, wherein the at least one conductive fiber is free from connection to a voltage power source.

2. The plasma tube according to claim 1, wherein a portion of the conductive fiber is encased within a protective coating.

3. The plasma tube according to claim 1, wherein a portion of the conductive fiber is in contact with the body.

4. The plasma tube according to claim 1, wherein the conductive fiber comprises a material selected from the group consisting of tantalum, tungsten, gold, copper, silver, molybdenum, aluminum, carbon, graphite, palladium, platinum, ceramics, and composites or compositions comprising at least one of the foregoing materials.

5. The plasma tube according to claim 1, wherein the conductive fiber is a platinum coated silicon carbide fiber.

6. The plasma tube according to claim 1, wherein the conductive fiber comprises a length of less than about 10 millimeters.

7. The plasma tube according to claim 1, wherein the conductive fiber comprises a length of about 3 millimeters to about 5 millimeters.

8. The plasma tube according to claim 1, wherein the cylindrical body comprises a material selected from the group consisting of sapphire, quartz, alumina coated quartz and combinations comprising at least one the materials.

9. The plasma tube according to claim 2, wherein the protective coating comprises a dielectric material.

10. The plasma tube according to claim 9, wherein the dielectric material is silicon dioxide.

11. The plasma tube according to claim 1, wherein the conductive fiber is secured to an inner surface of the plasma tube.

12. The plasma tube according to claim 8, wherein the conductive fiber is secured to the body at an angle substantially parallel to a length of the tube.

13. The plasma tube according to claim 8, wherein the at least one fiber has a thickness less than about 100 microns.

14. A plasma tool comprising:

a plasma generating chamber comprising a plasma tube, wherein the plasma tube comprises an open ended cylindrical body, wherein the body includes a gas inlet at one end an outlet opening at an other end, and at least one conductive fiber secured to the body and positioned to enhance an electric field, wherein the at least one conductive fiber is free from connection to a voltage power source; and

an energy source in operative communication with the plasma tube.

15. The plasma tool according to claim 14, wherein the energy source is selected from the group consisting of microwave energy, radiofrequency energy, and a combination comprising at least one of the foregoing energy sources.

16. The plasma tool according to claim 14, wherein the conductive fiber is encased with a dielectric material.

17. The plasma tool according to claim 14, wherein the conductive fiber comprises a material selected from the group consisting of tantalum, tungsten, molybdenum, aluminum, carbon, graphite, palladium, gold, copper, silver, platinum, ceramics, and composites or compositions comprising at least one of the foregoing materials.

18. The plasma tool according to claim 14, wherein the conductive fiber is a platinum coated silicon carbide fiber.

19. The plasma tool according to claim 14, wherein the conductive fiber is secured to an inner surface of the plasma tube.

20. The plasma tool according to claim 14, further comprising a light source, wherein radiation emitted from the light source is focused at a point within the plasma tube.

21. The plasma tool according to claim 20, wherein the radiation comprises ultraviolet radiation.

22. The plasma tool according to claim 20, wherein the at least one fiber has a thickness less than about 100 microns.

23. The plasma discharge tool according to claim 14, wherein the at least one fiber is at least partially aligned with the electric field.

24. The plasma discharge tool according to claim 14, wherein the at least one fiber is at substantially parallel to the applied electric field.

25. A process for reducing the electric field breakdown point of a gas, the process comprising:

securing a conductive fiber to a surface of a plasma tube, wherein the plasma tube comprises an open ended cylindrical body, wherein the body includes a gas inlet at one end, an outlet at an other end, and at least one conductive fiber in contact with the body and positioned to enhance an electric field, wherein the at least one conductive fiber is free from connection to a voltage power source;

flowing a gas into the gas inlet of the plasma tube;

applying an electric field to the gas flowing in the plasma tube to form a plasma; and

discharging the plasma from the outlet of the plasma tube.

26. The process according to claim 25, further comprising focusing radiation emitted from a light source at a point within the plasma tube.

27. The process of claim 25, wherein the applied electric field is generated from an energy source selected from the group consisting of microwave energy, radiofrequency energy, and combinations comprising at least one of the energy sources.

28. The process of claim 25, wherein the conductive fiber comprises a material selected from the group consisting of tantalum, tungsten, gold, copper, silver, molybdenum, aluminum, carbon, graphite, palladium, platinum, ceramics, and composites or compositions comprising at least one of the foregoing materials.

29. The process of claim 25, wherein the conductive fiber is secured to the body at an angle substantially parallel to the plasma tube.

30. The process of claim 25, wherein the at least one fiber has a thickness less than about 100 microns.

31. The process of claim 25, wherein the gas flows at a pressure less than 1 atmosphere.

32. The plasma tube according to claim 1, wherein the at least one conductive fiber is separated from an additional conductive fiber by a distance greater than about 3 millimeters.

33. The plasma tube according to claim 14, wherein the at least one conductive fiber is separated from an additional conductive fiber by a distance greater than about 3 millimeters.

34. The process according to claim 25, further comprising securing an additional conductive fiber to the plasma tube positioned to enhance the electric field, wherein the additional conductive fiber is separated from the conductive fiber by a distance greater than about 3 millimeters.

35. The process according to claim 25, wherein the gas flows at a pressure greater than 1 atmosphere.

36. The process according to claim 25, wherein the gas flows at a pressure up to about 5 atmospheres.